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(71) Applicant

Mannesmann Rexroth GmbH (FR Germany),  
Jahnstrasse, 8770 Lohr/Main, Federal Republic of  
Germany

(72) Inventors

Josef Distler  
Gunter Fertig

(74) Agent and/or Address for Service

A R Davies & Co,  
27 Imperial Square, Cheltenham GL50 1RQ

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## (54) A switching valve with brake pistons

(57) A valve with a control piston 11 for controlling the flow of pressure medium to a traction motor 40 is provided with brake pistons 15, 16 which are effective in both directions of travel and are controlled by the pump supply pressure. The control is so arranged that when the pump supply pressure rises fluid passes into a control chamber 55 through slots 57, 56 so that the appropriate brake piston 15, 16 is gradually opened against spring 18, in order to convey away to the reservoir T the pressure medium flowing back from the traction motor, while if the pressure drops off fluid leaves chamber 55 via non-return valve 60 and channel 58 so that the brake piston is quickly closed and thereby the flowback to the reservoir is throttled by an edge 52 of the piston. By this means a vehicle travelling downhill or a descending load may be effectively braked.

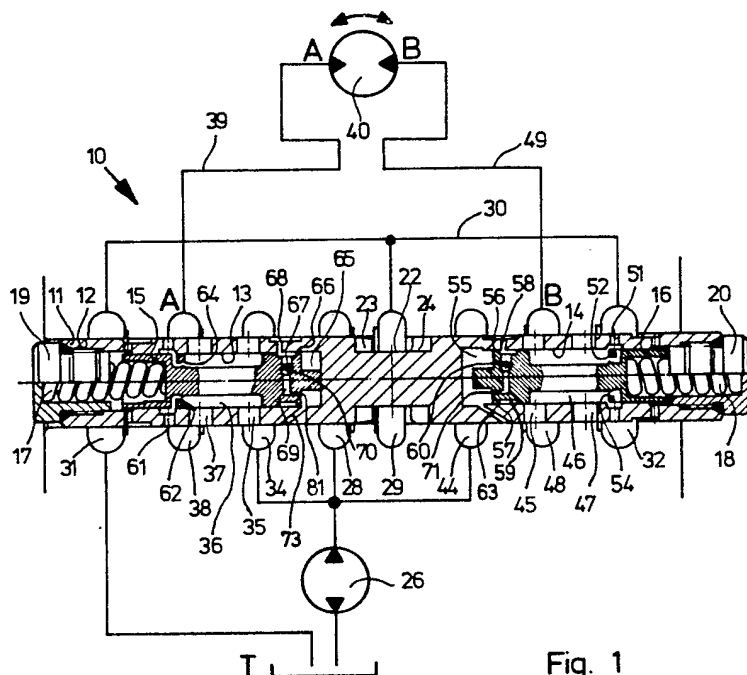
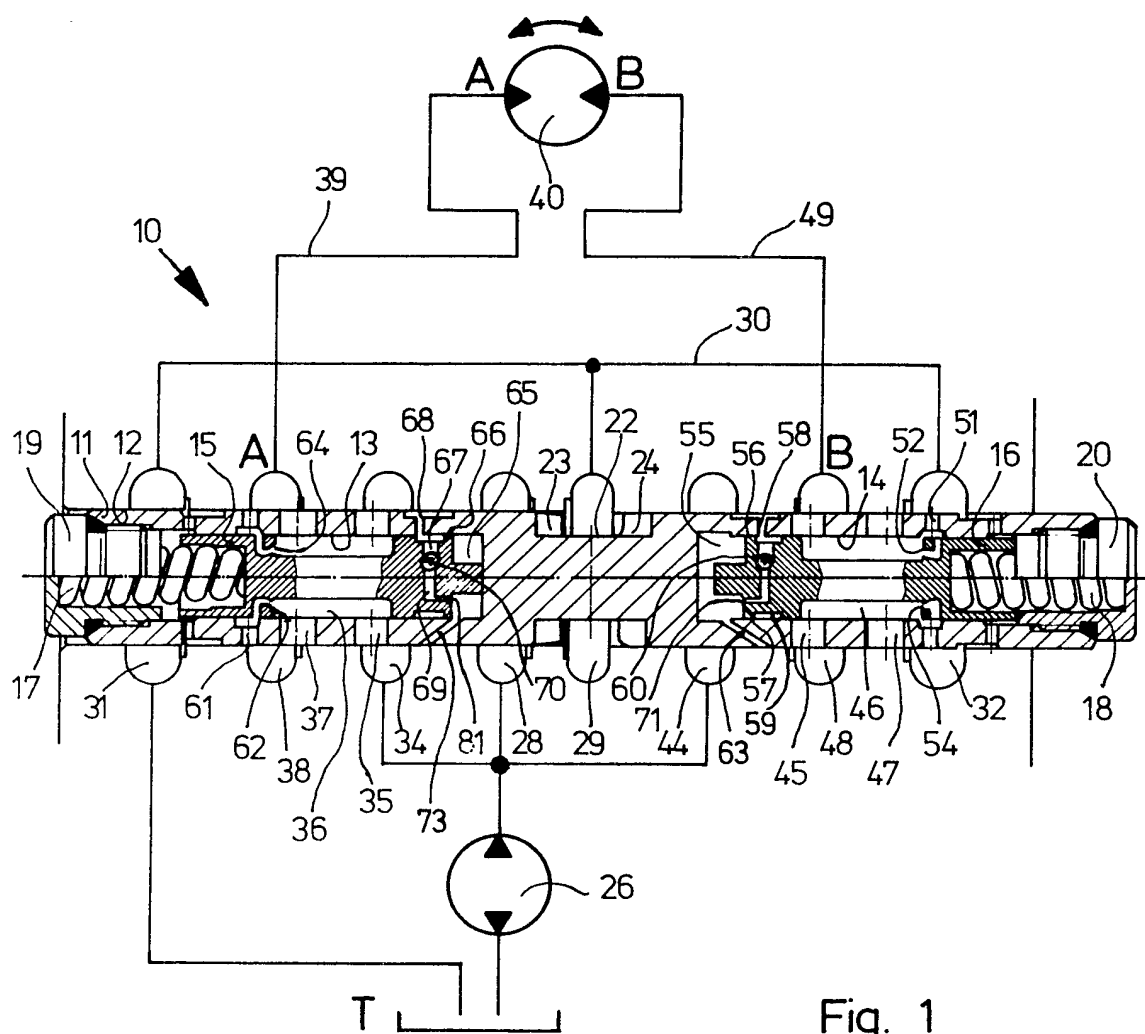


Fig. 1

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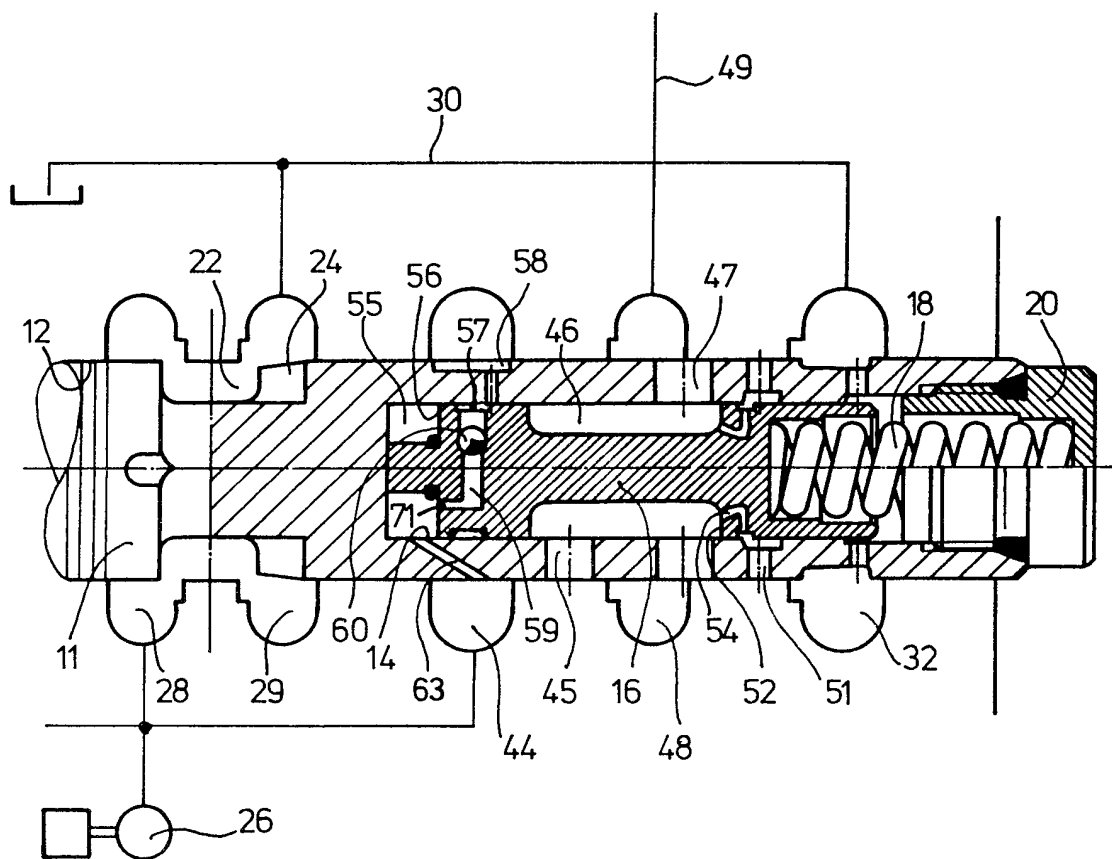


Fig. 2

## SPECIFICATION

### A switching valve with brake pistons

5 The invention concerns a switching valve with  
brake pistons of the kind comprising a control  
piston provided with boreholes in each of  
which a brake piston is provided, each brake  
10 piston, in the operating position of the control  
piston, being displaced in the direction of  
opening, against the force of a spring bearing  
against the control piston, by the supply pres-  
sure of the pump being delivered into a  
15 control chamber between the brake piston and  
the control piston, during which displacement  
a controlling cross-sectional area for the ex-  
haust flow of the pressure medium from the  
fluid operated device to the reservoir is  
20 opened, and which brake piston is displaced  
by the spring in the direction of closure when  
the supply pressure is dropping, during which  
displacement the controlling cross-sectional  
area is throttled.

The function of such valves with brake  
25 pistons is to prevent a vehicle, such as an  
excavator, from running forward quickly when  
travelling downhill and in making possible a  
safe descent. Such valves can also be used  
with other fluid-operated devices, for example  
30 a hydraulic crane motor for easing down a  
load.

In the switching valve according to the  
invention there is provided a double acting  
switching valve with two built-in brake pis-  
35 tons, so that the fluid-operated device can be  
braked in both directions of rotation, in case it  
is operating as a pump driven by a load.

The invention stems from a known valve, in  
which one brake piston in each case is fitted  
40 in a borehole in the end of the control piston  
of the switching valve. The brake piston is  
acted upon by the pump supply pressure and  
controls the flowback of the operating me-  
dium from the fluid-operated device to the  
45 reservoir. As long as the supply pressure of  
the pump, and thus the fluid-operated device  
pressure, is great enough, the brake piston  
opens fully the exhaust flow cross-sectional  
area for the pressure medium from the fluid-  
50 operated device to the reservoir. When the  
supply pressure is dropping, the brake piston  
is forced in the direction of closure by a  
spring and thereby has the effect that the  
fluid-operated device is braked because of the  
55 smaller exhaust flow cross-section. The brake  
pistons known until now, however, exhibit an  
unsatisfactory switching behaviour and an un-  
stable operating behaviour, which causes in-  
terruptions.

60 The problem which forms the basis for the  
present invention is therefore to develop a  
valve with brake pistons of the kind first-  
mentioned above in such a way that the  
operating behaviour is stabilised, even at fluc-  
65 tuating pressures, and reliable operation is

achieved in the "travelling" position as well  
as in the braking position of the brake piston.

70 According to the invention, a valve of the  
kind first referred to above is characterised in  
that the control chamber of each brake piston  
is connected, via an annular slot between the  
brake piston and the control piston borehole,  
a passage in the brake piston, and a non-  
75 return valve barring the way to the control  
chamber, with an annular recess which opens  
into an annular channel connected with the  
pump.

Other preferred features of the invention are  
set out in the accompanying subsidiary  
80 claims.

By means of the characterising features of  
the invention, the switching behaviour of the  
brake piston is stabilised. Thus when the  
traction motor is speeded up the opening  
85 motion of the brake piston takes place slowly  
and under damping, since the pressure in the  
control chamber of the brake piston rises  
gradually. A situation is avoided in which,  
when the control piston is displaced into an  
90 operating position, the pressure in the control  
chamber rises so suddenly that the brake  
piston makes excessively quick and sudden  
movements against the force of the spring,  
which lead to an unstable manner of opera-  
95 tion. Conversely, on going over to the braking  
position the motion of the brake piston takes  
place very quickly, so that the traction mo-  
tor—for reasons of safety—cannot take on  
any excessively high rate of revolution and the  
100 braking action is achieved quickly and reli-  
ably. The stroke of the control piston over a  
period of time resembles a sawtooth function,  
in which the exhaust flow cross-sectional area  
is increased gradually but is reduced rapidly.  
105 By means of the vent provided in the channel  
in addition to the non-return valve, the move-  
ment of the brake piston into the braking  
position is also lightly damped, so that oscilla-  
tions of the brake piston when there are  
110 fluctuations in pressure are avoided. A sepa-  
rate borehole opening into the control cham-  
ber ensures reliable start-up even when the  
pressure medium is cold.

In addition, the operating behaviour of the  
115 brake piston is enhanced by the features spe-  
cified in Claim 4. While the pressure medium  
is being fed to the consuming device via the  
first and second boreholes in the control pis-  
ton, which are connected with corresponding  
120 annular channels, the second boreholes are  
blocked off for the exhaust flow of the pres-  
sure medium from the fluid-operated device to  
the reservoir, which instead takes place  
through third boreholes in the control piston,  
125 the cross-section of which is controlled by the  
brake piston. By means of this flow route the  
hydraulic resistance in the supply of the pres-  
sure medium is reduced. Supply and exhaust  
thus take place at any given time via the  
130 second or third boreholes respectively.

In each brake piston a bypass passage bridges the guiding edge to the third boreholes, which is always open, so that the exhaust flow to the reservoir cannot be interrupted completely, which would result in an excessive rise in pressure. Furthermore, this bypass passage makes possible an immediate response on the part of the fluid-operated device when the control piston is deflected from the central position, since via the bypass passage there is a connection to the reservoir, even before the brake piston is displaced into the "travelling" position.

Hence the switching valve with brake pistons according to the invention is distinguished by an improved operating performance, has a relatively great damping effect when it switches from the braking position into the "travelling" position and a relatively small damping effect when it switches over from the "travelling" position into the braking position. Furthermore, fluttering and oscillating motions of the brake pistons are avoided and the vehicle cannot pitch up through fluctuations in pressure caused by oscillation.

An embodiment of the invention is described in greater detail below, reference being made to the accompanying drawing in which:

Figure 1 is a diagrammatic representation of a switching valve for a traction motor with the control piston and the brake pistons shown in section; and

Figure 2 shows, on a larger scale, a section through the left half of the control piston in the valve of Figure 1.

The switching valve 10 shown in the drawing consists of a control piston 11, which is displaceable within a borehole 12 in a housing (not shown in detail) and which is formed at opposite ends thereof with axial boreholes 13 and 14 in which brake pistons 15 and 16 respectively are reciprocable. Each brake piston 15, 16 is acted upon by a spring 17, 18 which bears against a control piston cap 19, 20.

The control piston 11 is provided at its centre with an annular peripheral recess 22 with precision control grooves 23 and 24. In Figure 2 the control piston 11 is shown in the central neutral position, in which the pressure medium delivered by a pump 26 is conveyed via an annular channel 28 in the housing, the annular recess 22 and an annular channel 29 in the housing into a conduit 30 which is connected with annular channels 31 and 32 in the housing as well as with the reservoir T. In the central position shown in Figure 2 the hydraulic fluid thus flows away to the reservoir without pressure. If the control piston is displaced to the right or left into an operating position, the pressure medium delivered by the pump 26 is throttled, to a greater or lesser extent, at the precision control grooves 23 and 24 and thereby undergoes a rise in

pressure. In Figure 1 the control piston 11 is in the operating position fully deflected to the right, in which the annular channel 28 is fully closed off and the entire output of the pump 26 flows via annular channel 34, a first borehole 35, annular recess 36 in the brake piston 15, a second borehole 37, an annular channel 38, and a conduit 39 to a traction motor 40, belonging for example to an excavator. Since the throttling of the pressure medium for control purposes takes place via the annular recess 22 and/or the precision control grooves 23, 24 the passage of the pressure medium from the annular channel 34 to the annular channel 38 is essentially unhindered.

On the opposite side of the control piston 11 the corresponding annular channels are indicated at 44 and 48, the first and second boreholes at 45 and 47, and the annular recess at 46. It can be seen from Figure 1 that the second boreholes 47 are blocked off by the position of the control piston 11 in the valve housing, so that the pressure medium flowing away from the traction motor 40 via a conduit 49 is conveyed via third boreholes 51 in the control piston 11 to the annular channel 32 and via the conduit 30 back to the reservoir T. The passage through the third boreholes 51 out of the annular recess 46 is regulated by a guiding edge 52 on the brake piston 16. Operating medium can always flow via a bypass passage 54 in the brake piston 16 or 15 into the annular channel 32.

In normal traffic operations, i.e. when proceeding on the level, uphill or accelerating, the brake piston 16 must be moved into the position shown in Figure 1, i.e. the guiding edge 52 must open up the entire cross-section of the third boreholes 51, so that the pressure medium displaced by the traction motor 40 can flow away unhindered to the reservoir and the motor can thus develop its full output.

For this purpose a control chamber 55 is provided between the brake piston 16 and the closed end of the borehole 14; it is connected via an annular slot 56 between the brake piston 16 and the borehole 14, an annular recess 57 in the brake piston and a passage 58 in the control piston 11 with the annular channel 44, in which the pressure is the pressure of the traction motor or, as the case may be, of the pump feed. By means of this pressure, when the vehicle is travelling or accelerating, the brake piston 16 is displaced against the force of the spring 18 towards the right, into the opened position, in which the guiding edge 52 opens up the third boreholes 51.

In Figure 1 the corresponding third boreholes on the other side of the control piston 11 are indicated at 61, the guiding edge of the brake piston 15 is indicated at 62, and the bypass passage at 64. Appropriate provision is made for a control chamber 65, an

annular slot 66, an annular recess 67 and a passage 68. Furthermore the control chamber 55/65 is connected at any given time via a passage 59/69 and a non-return valve

5 60/70 with the annular recess 57/67.

The right-hand half of the control piston is shown in Figure 2 on an enlarged scale.

When the control piston 11 is displaced, for starting-up or acceleration, towards the right  
10 into the operating position, as shown, so that the pressure of the pressure medium delivered by the pump 26 rises, the control chamber 55 is also immediately acted upon by this pressure via a borehole 63 in the control  
15 piston 11, so that on starting up, even with cold pressure medium, the buildup of pressure in the control chamber 55 begins at once, while the buildup of pressure via the annular slot 56 and the annular recess 57  
20 takes place more slowly. That is to say, by means of the rapid buildup of pressure in the control chamber 55 the brake piston 16 begins to move to the right, whereupon the borehole 63 serving for starting-up is then  
25 closed, so that the further buildup of pressure in the chamber 55 takes place via the annular slot 56 and thereby a damping of the movement of the brake piston is obtained. This damping is of material importance because a  
30 sudden rise in pressure in the control chamber 55 exerts a greater force on the brake piston 16 than the opposing force of the spring 18. By means of the damping, when pressure rises in the control chamber 55 a slow opening-up of the brake piston 16 is thereby  
35 obtained and the motion behaviour of the brake piston is stabilised.

In addition, even before the opening of the third boreholes 51 by the guiding edge 52,  
40 operating medium can flow via the bypass passage 54 from the traction motor via the conduit 49 and boreholes 51 to the annular channel connected with the reservoir, so that the traction motor responds immediately to  
45 the activation of the control piston 11. If the guiding edge 52 then opens up the cross-section of the third boreholes 51, the pressure medium displaced by the traction motor 40 can run off unhindered from the annular channel 48 via the first boreholes 45, the annular  
50 recess 46, the third boreholes 51 and the annular channel 32 to the reservoir.

If the vehicle now gets on to a downward path, so that the traction motor 40 is driven  
55 and operates as a pump, then the brake piston 16 must move to the braking position as quickly as possible, for reasons of safety. When proceeding downhill, it would be possible, without brake pistons, for the motor 40  
60 operating as a pump to dispatch so much operating medium away to the reservoir that the filling pressure in the supply is no longer adequate and the flow of operating medium to the motor 40 breaks off. In order to prevent  
65 this, the supply pressure must be maintained.

This is effected by the brake piston, which is switched into the exhaust flow as a throttle, and, controlled automatically by the supply pressure, ensures that the pressure in the supply is maintained.

70 Thus as soon as the motor 40 is operating as a pump, the pressure on the inflow side drops and with it the controlling pressure in the control chamber 55 also. The pressure  
75 medium in the control chamber 55 is emptied via the passage 59 and the now opening non-return valve 60 into the annular recess 57 and then via the channel 58 into the annular channel 44. By means of the reduction in  
80 pressure in the control chamber 55 the spring 18 moves the brake piston 16 in the direction of closure, in which direction the exhaust flow is monitored by the guiding edge 52, so as to maintain the supply pressure even when a  
85 downhill slope tends to cause a reduction in this pressure.

If the supply pressure drops further, the brake piston also reduces the exhaust flow cross-section further, until the supply pressure  
90 is constant again. By controlling the exhaust flow cross-section the maximum operating pressure equal to the braking pressure can be adjusted in the conduit 49 of the motor 40, so that the motor 40 is braked and a descent  
95 free of danger is made possible. Since the exhaust flow cross-section is controlled by the supply pressure which obtains in the control chamber 55, the supply pressure is held constant at every revolution of the motor. The  
100 bypass passage 54 leaves permanently open a very small exhaust flow cross-section leading to the reservoir. The movement of the brake piston 16 into the braking position can be influenced by a jet 71 for which provision is  
105 made in the passage 59. Thereby, the pressure in the control chamber 55 cannot drop off instantaneously. The corresponding vent in the brake piston 15 is indicated at 81.

The other brake piston 15 is likewise controlled, in the operating position illustrated in  
110 Figure 1, by the supply pressure, so that the connection from the annular recess 36 to the reservoir via the annular channel 31 is interrupted.

## 115 CLAIMS

1. A valve for the control of the flow of pressure medium between a fluid operated device and a pump or reservoir, comprising a  
120 control piston provided with boreholes in each of which a brake piston is provided, each brake piston, in the operating position of the control piston, being displaced in the direction of opening, against the force of a spring  
125 bearing against the control piston, by the supply pressure of the pump being delivered into a control chamber between the brake piston and the control piston, during which displacement a controlling cross-sectional area  
130 for the exhaust flow of the pressure medium

from the fluid operated device to the reservoir is opened, and which brake piston is displaced by the spring in the direction of closure when the supply pressure is dropping, during which displacement the controlling cross-sectional area is throttled, wherein the control chamber of each brake piston is connected, via an annular slot between the brake piston and the control piston borehole, a passage in the brake piston, and a non-return valve barring the way to the control chamber, with an annular recess which opens into an annular channel connected with the pump.

2. A valve according to Claim 1, wherein a jet is provided in the passage between the control chamber and the non-return valve.

3. A valve according to Claim 1 or Claim 2, wherein a borehole is provided between the control chamber and the annular channel connected with the pump, which borehole, in the central position of the control piston, opens into the annular channel and in the operating position is closed off.

4. A valve according to any one of Claims 1 to 3, wherein the control piston includes first, second and third boreholes and the brake pistons each include a second annular recess which, in the operating position of the control piston, is connected via the first boreholes with the annular channel connected with the pump and via the second boreholes with an annular channel connected with the supply to the fluid-operated device, and which is connected via the first boreholes with an annular channel connected with the exhaust flow from the fluid-operated device, and via the third boreholes, controlled by a guiding edge of the brake piston, with an annular channel connected with the reservoir.

5. A valve according to Claim 4, wherein, proceeding from a central annular recess in the control piston, in order to direct the pump pressure medium away to the reservoir, there are provided, at both ends of the control piston: a passage connected to the respective first annular recess in the brake piston, and first, second and third boreholes.

6. A valve according to Claim 5, wherein there is provided in each brake piston a by-pass passage by means of which the connection between the associated first borehole and the third borehole in the control piston is kept open.

7. A valve substantially as hereinbefore described with reference to the accompanying drawings.